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APPLICABILITY OF EQUIVALENT DISTANCE CONCEPT FOR PERFORMANCE EVALUATION TO CANALS WITH REGULATING STRUCTURES - THE CASE OF KALANKUTTIYA BRANCH CANAL

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I INTRODUCTION

It is generally believed that performance at any point in an irrigation system is affected by its location with respect to the source of water and its mode of delivery, including the characteristics and operation of the control structures, if any. Distinctions are made between the "head" (H), "middle" (M) and "tail" (T) of a canal network, usually defined in terms of linear distance. The upper third of an irrigation canal is considered as H, the middle third as M and the lower third as T. Reliability, adequacy and predictability of irrigation water deliveries are expected to decline from H to T.

The concept of "Equivalent Distance" proposed by MURRAY-RUST[1] is an attempt at addressing the inability of linear distance to explain observed non-linear decline in performance as one goes down the system.

The concept is based on a consideration of the canal system as a combination of different reaches characterized by a total supply and a total demand. It is hypothesized that if the ratio of demand to supply is low, then the reach (or location) in question is advantageously located and vice versa. A direct consequence is that offtakes at the head of a main conveyance canal are comparatively well located with respect to those lower down the system.

MURRAY-RUST illustrates the value of the equivalent distance concept in explaining observed water level fluctuations in the Sharkpur distributorey canal in Pakistan. This provides an opportunity to assess distance effects in a canal without significant effect of control structures. The distributory canal flow is divided at each offtake in proportion to their respective command areas by means of proportional dividers.

On the other hand the fluctuations in water levels could be considerably reduced by the presence and proper operation of appropriate regulating structures. The Kalankuttiya branch canal situated in the Mahaweli System H of north-central Sri Lanka represents a case of a canal where water levels are regulated by means of duck-bill weirs.

This paper is a preliminary attempt to explore the applicability of the equivalent distance concept to the Kalankuttiya branch canal, making use of already available data.

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1 D. Hammond Murray-Rust (1987), "Equivalent Distance - A New Methodology for Performance Evaluation", Draft Paper, IIMI-Pakistan.

II RECAPITULATION OF EQUIVALENT DISTANCE CONCEPT

We shall suppose that the canal is made up of a number of reaches, say N.

Consider the reach n

Let L_n = Length of reach n
Q_n = Discharge into reach n
Q_{n+1} = Discharge out of reach n

==> Demand in reach n = $Q_n - Q_{n+1}$

Definitions :

(i) Equivalent Length of reach n, $(L_e)_n = \frac{(Q_n - Q_{n+1})}{Q_n} \times L_n$ ------- (1)

(ii) Equivalent Distance upto reach n, $(D_e)_n = \sum_{n=1}^{N} (L_e)_n$ ------- (2)

It will be observed that $(L_e)_n$ will tend to zero if:

(i) Q_{n+1} is nearly equal to Q_n, i.e. demand in reach n is small, (e.g. a small canal taking off from a relatively larger canal),
or (ii) L_n tends to zero, i.e. reach n is of negligible length.

The sample calculation performed by MURRAY-RUST is for the case of a main canal 50,000 feet long with uniform demand along its length. The ratio of demand (discharge into the lower order canals) to supply (parent canal flow) at the head of the parent canal is relatively small, whereas the demand:supply ratio at the tail-end is relatively high. The equivalent lengths of the reaches therefore increase sharply towards the tail. This accounts for the exponential shape of the relationship between equivalent and actual distances. The shape of the curve would be expected to differ in the case of a non-uniform demand pattern.

It is also shown in this example that the tail of the main canal (defined as the last third of the total canal equivalent distance) is restricted to a much narrower portion than one-third of its linear distance from the tail, i.e. the last 2000 feet instead of the last 16,667 feet.

We would however like to highlight the fact that the definitions of head, middle and tail are still based on the assumption that each of these zones constitutes one-third of the total distance, be it linear or equivalent. This certainly is the reason for obtaining a tail section as narrow as 2000 feet out of a total canal length of 50,000 feet.

Whilst admitting that the use of the one-third proportion to define head, middle and tail sections of canals is perhaps not the best approach, we do not intend to address the appropriateness of this tradition in this paper. The scope of this paper is limited to testing the applicability of the equivalent distance concept to a canal influenced by the presence of regulating structures, namely Kalankuttiya branch canal.

III DESCRIPTION OF KALANKUTTIYA BRANCH CANAL

The Kalankuttiya sub-system forms part of System H of the main Mahaweli system, in the North-Central Province (NCP) of Sri Lanka. The 1.86 x 10^6 m^3 Kalankuttiya tank at the head of this sub-system commands an irrigable area of 2040 ha. The tank's own catchment area is only 26 km^2 but its water resources are being supplemented, since 1977, by Mahaweli water diverted to the larger Kalawewa reservoir.

The conveyance and distribution system is made up of a 11.5 km long branch canal having a maximum design capacity of 5.66 m^3/s (200 cusecs) conveying water from the Kalankuttiya tank to 20 distributory canals, which in turn feed a network of field canals. Each field canal irrigates between 6 and 25 farm allotments of 1 ha size through a 15 cm (6 in) pipe outlet. The number of farms served by a field canal varies due to the undulating nature of the land and the wide range in sizes of the micro-catchment land units in this topography.

Nine duck-bill weirs constructed along the branch canal help maintain hydraulic head at distributory canal offtakes irrespective of fluctuations of discharge in the branch canal. Control of discharges into a majority of the distributory canals is thereby enhanced. Figure 1 is a schematic representation of the Kalankuttiya branch canal.

IV APPLICATIONS OF EQUIVALENT DISTANCE CONCEPT

The concept was applied to data collected on the Kalankuttiya sub-system by the Mahaweli Economic Agency during the Maha (wet) season 1986-87. The entire command area of 2040 ha was cultivated to rice during this season.

Three distinct periods of water issue were examined, namely :

(a) Land soaking and land preparation period, from 21 October to 25 November 1986; water was issued continuously to all 20 distributory canals throughout this period;
(b) Rotational water issue period from 16 to 25 January 1987;
(c) Rotational water issue period from 7 to 17 February 1987; the distributory canals downstream of 306D2 were served during the first 6 days while the upstream distributories were served during the next 5 days; each of these two sub-periods were also examined.

"Theoretical" equivalent distances were also computed along the branch canal for each of these cases.

Actual vs Equivalent Distance relationships for the above cases are shown in Tables 1 to 6 and Figures 2 to 9.

Table 7 and Figure 10 describe the water delivered per unit area to the different distributory canals for the above three periods.

Figures 11 and 12 pertain to the land preparation period only. They seek to examine the degree of correlation between distributory canal water deliveries

and actual distance (Figure 11) and equivalent distance (Figure 12).

V DISCUSSION OF RESULTS AND CONCLUSIONS

The theoretical relationship between actual and equivalent distances on the Kalankuttiya branch canal (Table 1 and Figure 2) has been derived on the basis of a water requirement of 2 l/s/ha and 30% overall conveyance losses. The losses are assumed to be proportional to the demand under each distributory canal.

The H, M, T sections are remarkably different, depending on whether the computation is based on actual or equivalent distances. If actual distances. are used (together with the traditional one-third proportion), the head will comprise canals 305D1 to 305D4 (6 distributory canals), the middle from 306D1 to 306D4 (8 Canals), while the remaining 6 canals will constitute the tail.

If H, M, T sections are defined using theoretical equivalent distances (Table 1), the 14 canals from 305D1 to 306D4 will constitute the head, the middle will be represented only by canal 306D5, while the remaining 5 distributories will belong to the tail.

The theoretical curve (Figure 2) assumes no regulating structures. On the other hand the actually observed data, and thereby the equivalent distance curves based on this data, take into account the regulating effect of the duck-bill weirs as well as the influence of distributory offtake gate operations. The H, M, T sections based on the equivalent distance values of Tables 2, 3 and 4 (see also figures 3,4, and 5) are identical to those obtained using the theoretical curve, i.e. H from 305D1 to 306D4, M only 306D5 and T from 309D4 downwards.

The influence of the operational mode of the canal on the equivalent distance concept and the H, M, T definition is brought to light by a closer look at the 7-17 February rotational period and the two sub-periods within this rotation (Tables 4, 5 and 6, and Figures 8 and 9). When only the upper portion of the Kalankuttiya branch canal is being served, any consideration of H, M, T sections should be confined only to this portion and not the whole length of canal. A similar argument holds when only the lower portion of the canal is being served. However the theoretical and actual H, M, T definitions for a particular time period and operational mode are seen to be identical.

That is, <u>the theoretical H, M, T locations (defined in terms of equivalent distance for a given operational scenario) in Kalankuttiya branch canal are unaltered by the actual system design and operation</u>.

The equivalent distance curves derived using observed data for each of the periods described in section IV follow the same trend as the theoretical curve, as evidenced by Figure 6. The differences between these curves reflect differences in the demand to supply ratios at the various distributory canals during the different time periods concerned (see Figure 7). The fact that the curves are not identical implies that the equivalent distances in the case of a canal with regulating structures should not be considered as intrinsic properties of that canal. The equivalent distance

values could vary with time in response to the demand-supply situation and the operational mode.

Let us now examine the relative impacts of the two design concepts referred to in this paper, namely proportional dividers and duck-bill weirs, on equivalent lengths and distances.

In the case of proportional dividers, the ratio of demand to supply, i.e. $(Qn - Qn+1)/Qn$ in equation (1), is constant. Thus the equivalent length Le for the reach in question would also be constant. MURRAY-RUST has shown that the variability of main canal water levels increases with increasing distance from the head of the parent canal. All the variability in parent canal water level is transferred to secondary canal discharge. The coefficient of variation of the parent canal water levels is thus a good indicator of the variability of secondary canal discharge. The water delivered to the secondary canals is therefore seen to be influenced by their location with respect to the head of the parent canal.

In the case of duck-bill weirs and gated distributory offtakes, the demand to supply ratio, and hence the equivalent length Le for a particular reach will not only be a function of main canal water level but will also depend on the offtake gate operation. In a canal with regulating structures the water deliveries to the various distributory canals would therefore not be expected to be primarily affected by their distance from the head of the parent canal.

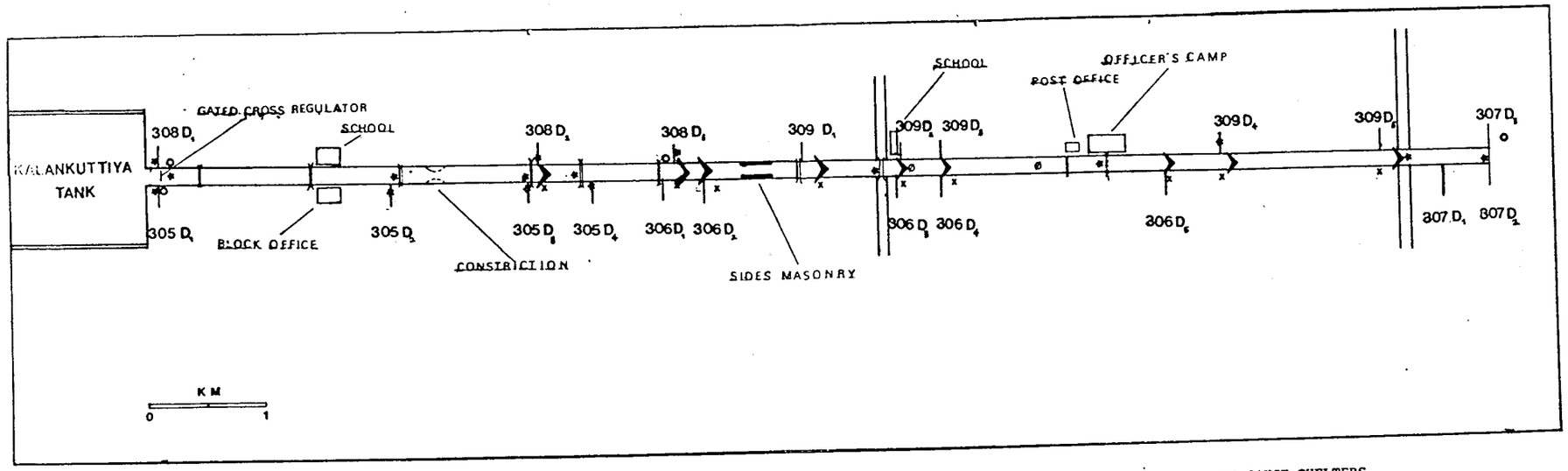
This is amply illustrated in Figures 10, 11 and 12 where no marked correlation is observed between water deliveries to the distributory canals and (actual and equivalent) distances from the head of the parent canal. That is, although water deliveries to the distributory canals are inequitable, the inequity is not related to the distance, either actual or equivalent. In this context the singular behavior of distributory 309D2 which exhibits consistently low water deliveries (see also Table 7) perhaps has a physical explanation. That is, a part of the area expected to be served by this canal might also be receiving water from another tank nearby (Migalewa tank). It might therefore not be drawing its full complement of water from the Kalankuttiya branch canal. The distributories at the tail end of the branch canal are nevertheless well supplied with water.

This leads us to the conclusion that the equivalent distance concept is not sufficiently sensitive to examine inequities in the regulated (via duck-bill weirs) Kalankuttiya sub-system.

A similar conclusion might be reached for the case of a primary canal regulated by means of cross-regulators instead of duck-bill weirs. Here the water delivery into secondary canals would depend upon the operation of two gates (the cross-regulator and the offtake) and not on the spatial location of the secondary canal. The research planned for the Kirindi Oya right bank main canal, which exhibits this type of regulation, should help to confirm this hypothesis.

ACKNOWLEDGEMENTS

Rajiv de Silva's help in performing some of the initial computations is gratefully acknowledged.



- AUTOMATIC GAUGE SHELTERS
- BRIDGES
- DUCK BILL WEIRS
- STAFF GAUGES
- CHECK & DROP STRUCTURES

FIGURE 1

Table 1

KALANKUTTIYA BRANCH CANAL - CALCULATION OF THEORETICAL EQUIVALENT DISTANCES
ASSUMING WATER REQUIREMENT OF 2L/S/HA FOR DISTRIBUTORY CANAL COMMAND AREAS
AND 30% OVERALL CONVEYANCE LOSSES

DISTRIBUTORY CANAL NO.	COMMAND AREA (ha)	LENGTH OF REACH (m)	CUMULATIVE DISTANCE FROM HEAD (m)	THEORETICAL DEMAND OF D. CANAL (m3/s)	BRANCH CANAL DESIGN DISCHARGE (m3/s)	EQUIVALENT LENGTH OF REACH (m)	EQUIVALENT DISTANCE FROM HEAD (m)
305D1	295.5	122.0	122.0	0.844	5.828	17.7	17.7
308D1	71.9	0.3	122.3	0.205	4.983	.0	17.7
305D2	76.9	1929.9	2052.2	0.220	4.778	88.7	106.4
305D3	106.3	1131.7	3183.9	0.304	4.558	75.4	181.8
308D2	69.8	63.4	3247.3	0.199	4.255	3.0	184.8
305D4	70.9	399.4	3646.7	0.203	4.055	20.0	204.8
306D1	85.0	551.8	4198.5	0.243	3.853	34.8	239.5
308D3	119.4	140.2	4338.8	0.341	3.610	13.3	252.8
306D2	109.1	230.2	4569.0	0.312	3.269	22.0	274.7
309D1	59.7	756.1	5325.0	0.171	2.957	43.6	318.4
306D3	35.4	759.1	6084.2	0.101	2.786	27.6	345.9
309D2	67.8	64.0	6148.2	0.194	2.685	4.6	350.5
309D3	104.3	379.0	6527.2	0.298	2.491	45.3	395.9
306D4	49.6	0.3	6527.5	0.142	2.193	.0	395.9
306D5	177.9	1893.9	8421.4	0.508	2.052	469.2	865.1
309D4	96.0	398.8	8820.2	0.274	1.543	70.9	935.9
309D5	84.0	1145.1	9965.3	0.240	1.269	216.5	1152.5
307D1	67.6	718.9	10684.2	0.193	1.029	134.9	1287.4
307D2	70.9	361.9	11046.1	0.203	0.836	87.7	1375.1
307D3	221.7	0.3	11046.4	0.633	0.633	0.3	1375.4

N.B. REACH ==> Distance between successive Distributory Canals

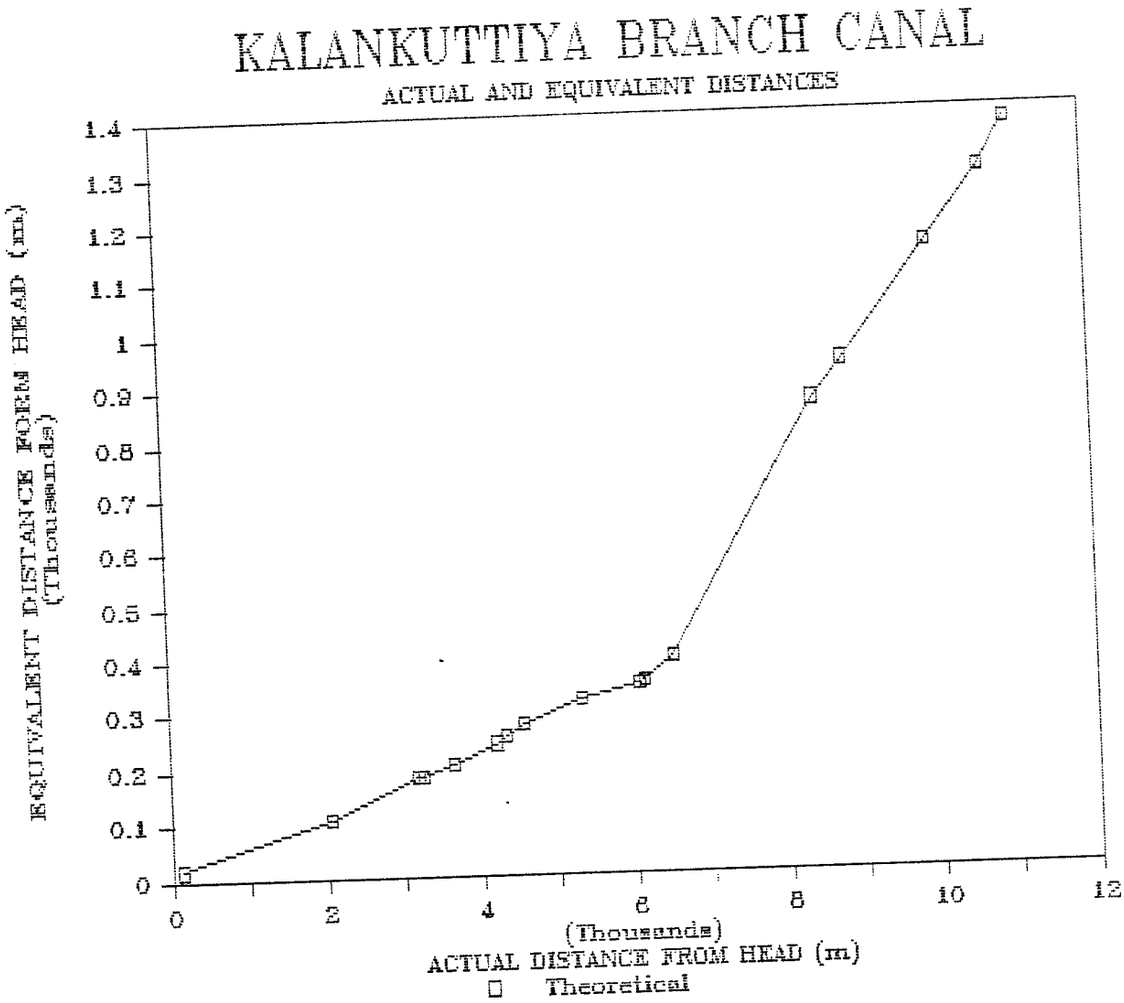

KALANKUTTIYA BRANCH CANAL
ACTUAL AND EQUIVALENT DISTANCES
EQUIVALENT DISTANCE FROM HEAD (m)
(Thousands)
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
8
10
12
(Thousands)
ACTUAL DISTANCE FROM HEAD (m)
Theoretical

FIGURE 2

Table 2

KALANKUTTIYA BRANCH CANAL - CALCULATION OF EQUIVALENT DISTANCES
USING ACTUALLY OBSERVED WATER FLOWS FOR THE LAND PREPARATION PERIOD 21 OCT-25 NOV 1986
OF THE MAHA SEASON 1986/87

DISTRIBUTORY CANAL NO.	COMMAND AREA (ha)	LENGTH OF REACH (m)	CUMULATIVE DISTANCE FROM HEAD (m)	AVERAGE DELIVERY TO D. CANAL (m3/s)	AVERAGE DISCHARGE IN BRANCH CANAL (m3/s)	EQUIVALENT LENGTH OF REACH (m)	EQUIVALENT DISTANCE FROM HEAD (m)
305D1	295.5	122.0	122.0	0.515	3.053	20.6	20.6
308D1	71.9	0.3	122.3	0.114	2.539	.0	20.6
305D2	76.9	1929.9	2052.1	0.106	2.425	84.5	105.1
305D3	106.3	1131.7	3183.8	0.107	2.319	52.4	157.5
308D2	69.8	63.4	3247.3	0.087	2.211	2.5	159.9
305D4	70.9	399.4	3646.6	0.112	2.124	21.1	181.0
306D1	85.0	551.8	4198.5	0.120	2.012	33.0	214.0
308D3	119.4	140.2	4338.7	0.125	1.892	9.3	223.3
306D2	109.1	230.2	4568.9	0.173	1.767	22.5	245.8
309D1	59.7	756.1	5325.0	0.078	1.594	37.1	282.9
306D3	35.4	759.1	6084.1	0.062	1.516	30.9	313.8
309D2	67.8	64.0	6148.2	0.031	1.454	1.4	315.2
309D3	104.3	379.0	6527.1	0.132	1.423	35.1	350.3
306D4	49.6	0.3	6527.4	0.105	1.291	.0	350.4
306D5	177.9	1893.9	8421.3	0.293	1.186	467.5	817.8
309D4	96.0	398.8	8820.1	0.136	0.893	60.5	878.4
309D5	84.0	1145.1	9965.2	0.153	0.758	231.9	1110.3
307D1	67.6	718.9	10684.1	0.102	0.604	121.3	1231.6
307D2	70.9	361.9	11046.0	0.110	0.502	79.4	1310.9
307D3	221.7	0.3	11046.3	0.392	0.392	0.3	1311.3

N.B. REACH ==> Distance between successive Distributory Canals

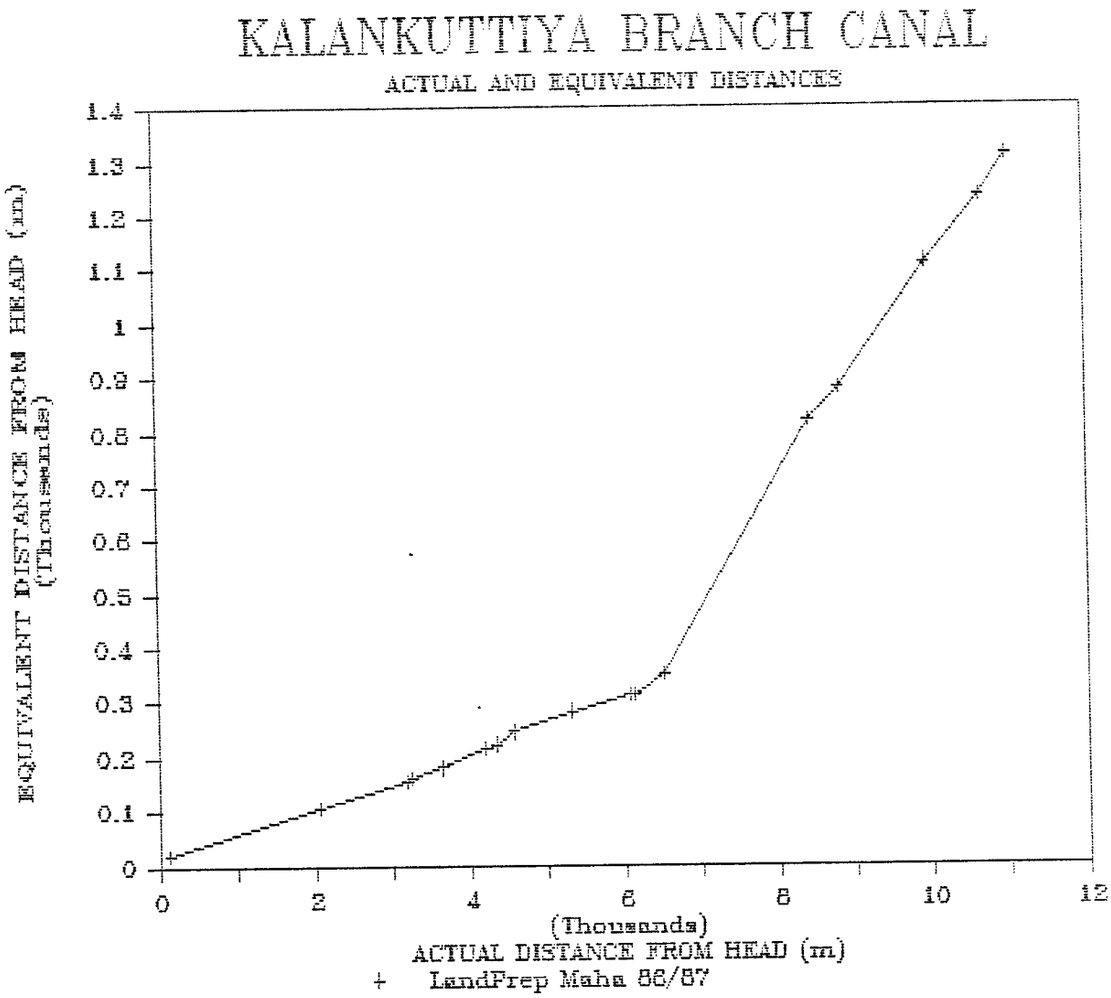

KALANKUTTIYA BRANCH CANAL
ACTUAL AND EQUIVALENT DISTANCES
EQUIVALENT DISTANCE FROM HEAD (km)
(Thousands)
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
8
10
12
(Thousands)
ACTUAL DISTANCE FROM HEAD (m)
+ LandFrep Maha 86/87

FIGURE 3

Table 3

KALANKUTTIYA BRANCH CANAL - CALCULATION OF EQUIVALENT DISTANCES
USING ACTUALLY OBSERVED WATER FLOWS FOR THE ROTATIONAL PERIOD 16-25 JAN 1987
OF THE MAHA SEASON 1986/87

DISTRIBUTORY CANAL NO.	COMMAND AREA (ha)	LENGTH OF REACH (m)	CUMULATIVE DISTANCE FROM HEAD (m)	AVERAGE DELIVERY TO D. CANAL (m3/s)	AVERAGE DISCHARGE IN BRANCH CANAL (m3/s)	EQUIVALENT LENGTH OF REACH (m)	EQUIVALENT DISTANCE FROM HEAD (m)
305D1	295.5	122.0	122.0	0.494	3.212	18.8	18.8
308D1	71.9	0.3	122.3	0.148	2.717	.0	18.8
305D2	76.9	1929.9	2052.1	0.117	2.569	87.8	106.6
305D3	106.3	1131.7	3183.8	0.140	2.452	64.8	171.4
308D2	69.8	63.4	3247.3	0.085	2.312	2.3	173.8
305D4	70.9	399.4	3646.6	0.110	2.227	19.8	193.5
306D1	85.0	551.8	4198.5	0.138	2.117	36.1	229.6
308D3	119.4	140.2	4338.7	0.143	1.978	10.1	239.7
306D2	109.1	230.2	4568.9	0.179	1.836	22.4	262.2
309D1	59.7	756.1	5325.0	0.104	1.657	47.7	309.9
306D3	35.4	759.1	6084.1	0.067	1.552	32.7	342.5
309D2	67.8	64.0	6148.2	0.058	1.485	2.5	345.0
309D3	104.3	379.0	6527.1	0.152	1.427	40.4	385.4
306D4	49.6	0.3	6527.4	0.078	1.275	.0	385.4
306D5	177.9	1893.9	8421.3	0.337	1.197	532.7	918.2
309D4	96.0	398.8	8820.1	0.171	0.860	79.3	997.4
309D5	84.0	1145.1	9965.2	0.168	0.689	279.9	1277.4
307D1	67.6	718.9	10684.1	0.095	0.521	131.0	1408.3
307D2	70.9	361.9	11046.0	0.093	0.426	79.4	1487.7
307D3	221.7	0.3	11046.3	0.332	0.332	0.3	1488.0

N.B. REACH ==> Distance between successive Distributory Canals

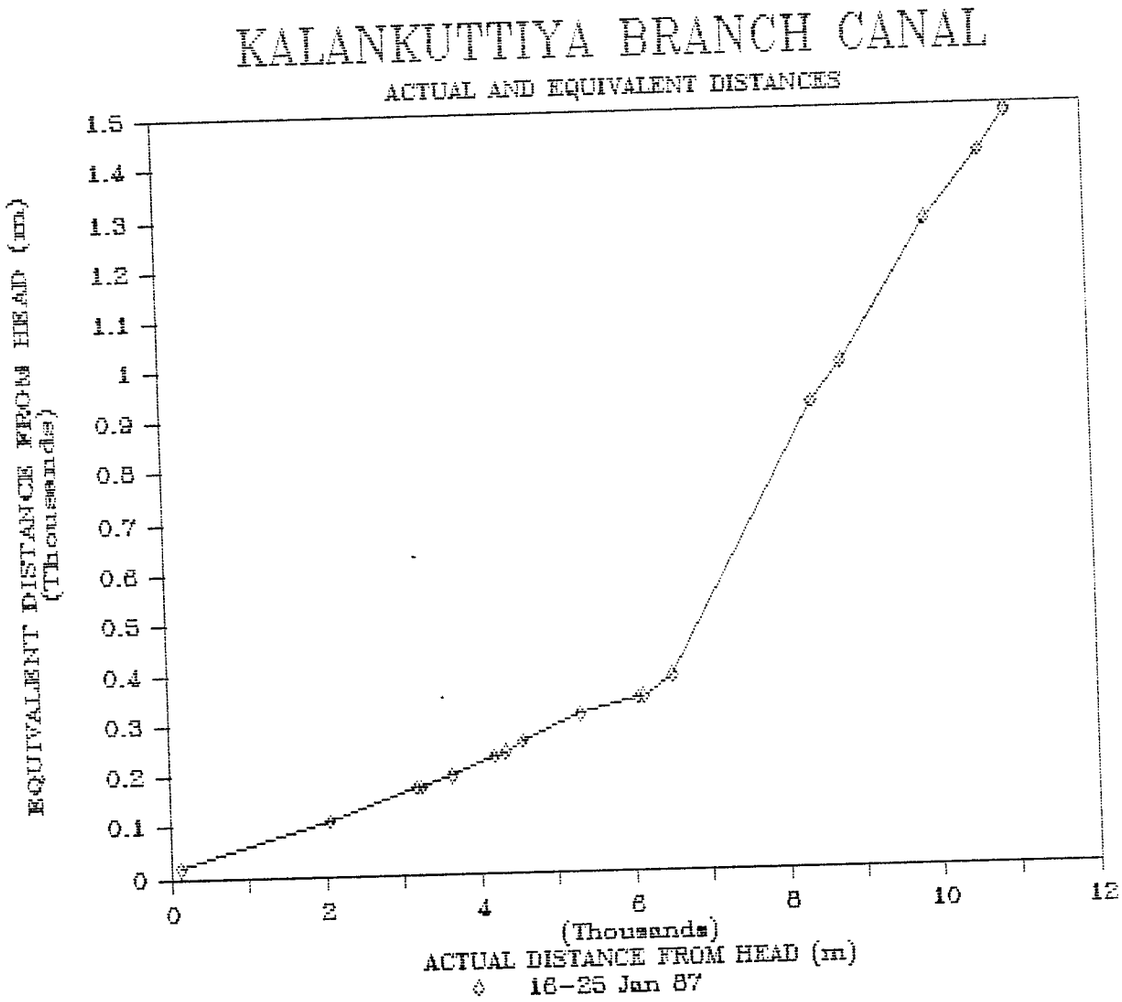

KALANKUTTIYA BRANCH CANAL
ACTUAL AND EQUIVALENT DISTANCES
EQUIVALENT DISTANCE FROM HEAD (m)
(Thousands)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
8
10
12
(Thousands)
ACTUAL DISTANCE FROM HEAD (m)
◊ 16-25 Jan 87

FIGURE 4

Table 4

KALANKUTTIYA BRANCH CANAL - CALCULATION OF EQUIVALENT DISTANCES
USING ACTUALLY OBSERVED WATER FLOWS FOR THE ROTATIONAL PERIOD 7-17 FEB 1987
OF THE MAHA SEASON 1986/87

DISTRIBUTORY CANAL NO.	COMMAND AREA (ha)	LENGTH OF REACH (m)	CUMULATIVE DISTANCE FROM HEAD (m)	AVERAGE DELIVERY TO D. CANAL (m3/s)	AVERAGE DISCHARGE IN BRANCH CANAL (m3/s)	EQUIVALENT LENGTH OF REACH (m)	EQUIVALENT DISTANCE FROM HEAD (m)
305D1	295.5	122.0	122.0	0.606	3.759	19.7	19.7
308D1	71.9	0.3	122.3	0.166	3.153	.0	19.7
305D2	76.9	1929.9	2052.1	0.170	2.987	109.6	129.2
305D3	106.3	1131.7	3183.8	0.202	2.818	81.3	210.5
308D2	69.8	63.4	3247.3	0.101	2.615	2.4	213.0
305D4	70.9	399.4	3646.6	0.142	2.514	22.6	235.6
306D1	85.0	551.8	4198.5	0.183	2.372	42.5	278.0
308D3	119.4	140.2	4338.7	0.209	2.190	13.4	291.4
306D2	109.1	230.2	4568.9	0.254	1.981	29.5	321.0
309D1	59.7	756.1	5325.0	0.142	1.727	62.0	383.0
306D3	35.4	759.1	6084.1	0.064	1.585	30.8	413.7
309D2	67.8	64.0	6148.2	0.054	1.521	2.3	416.0
309D3	104.3	379.0	6527.1	0.154	1.466	39.9	455.9
306D4	49.6	0.3	6527.4	0.088	1.312	.0	455.9
306D5	177.9	1893.9	8421.3	0.312	1.224	483.3	939.3
309D4	96.0	398.8	8820.1	0.171	0.911	74.8	1014.1
309D5	84.0	1145.1	9965.2	0.131	0.740	202.8	1216.8
307D1	67.6	718.9	10684.1	0.092	0.609	108.6	1325.4
307D2	70.9	361.9	11046.0	0.114	0.517	79.6	1405.0
307D3	221.7	0.3	11046.3	0.403	0.403	0.3	1405.4

N.B. REACH ==> Distance between successive Distributory Canals

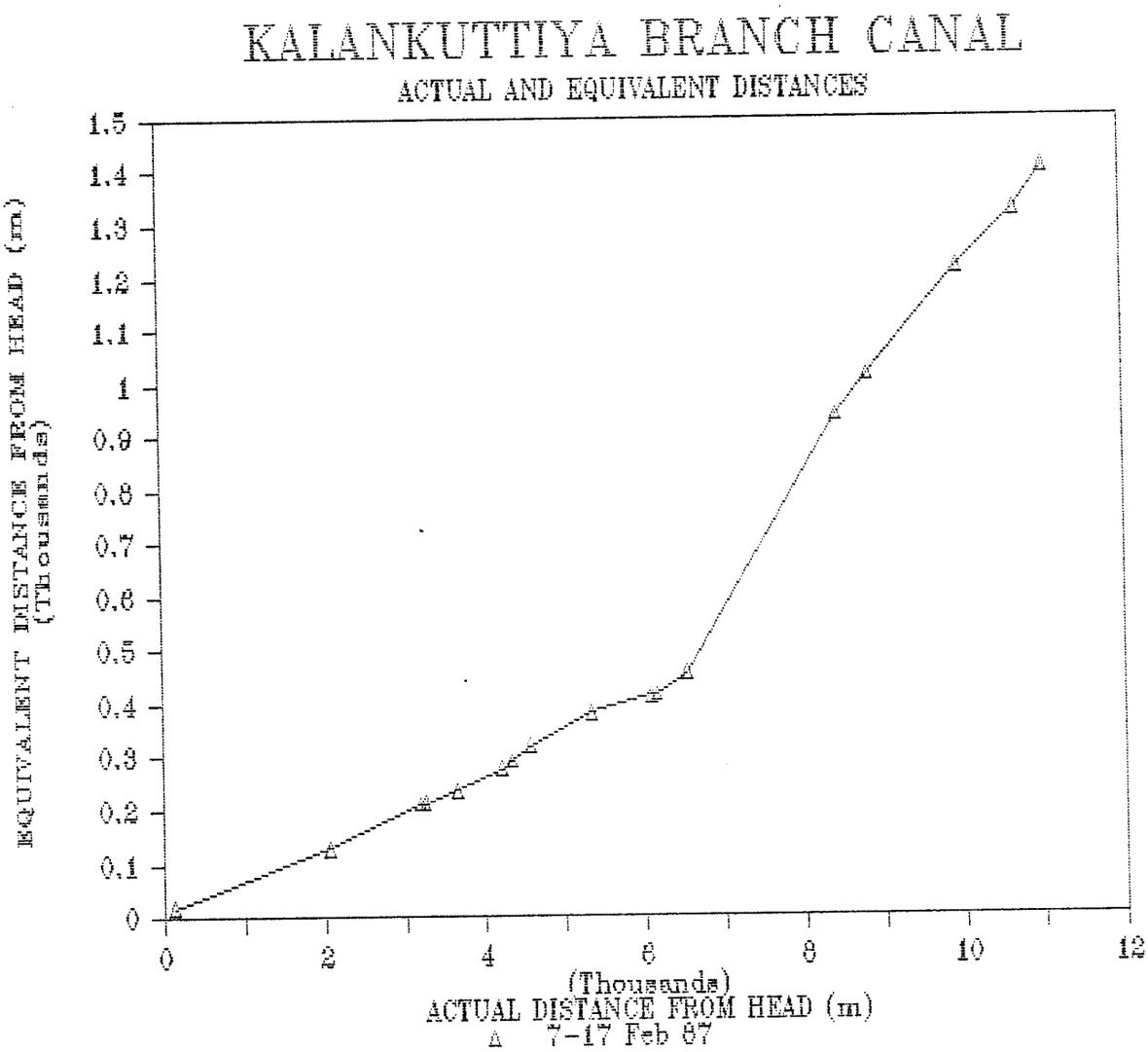

KALANKUTTIYA BRANCH CANAL
ACTUAL AND EQUIVALENT DISTANCES
EQUIVALENT DISTANCE FROM HEAD (m)
(Thousands)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
8
10
12
(Thousands)
ACTUAL DISTANCE FROM HEAD (m)
Δ 7-17 Feb 87

FIGURE 5

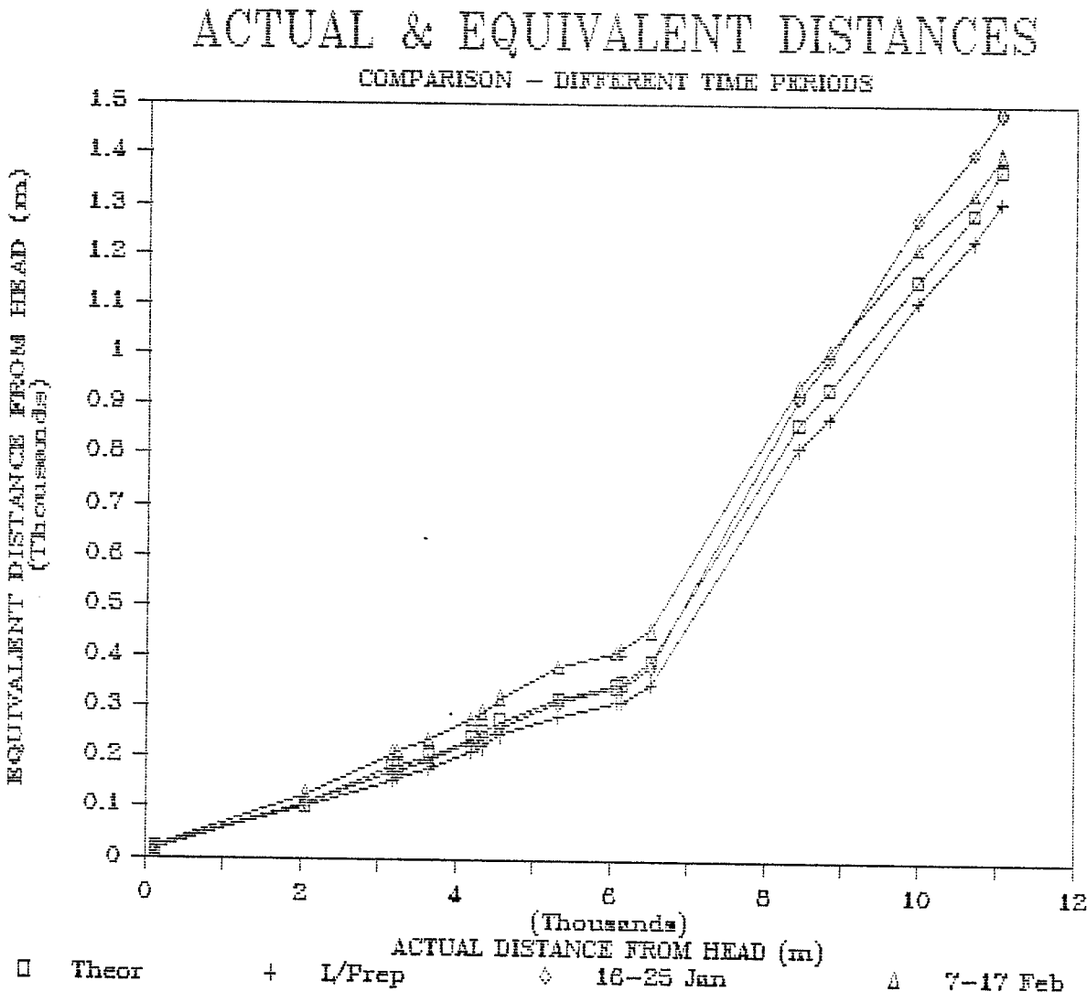

ACTUAL & EQUIVALENT DISTANCES
COMPARISON – DIFFERENT TIME PERIODS
EQUIVALENT DISTANCE FROM HEAD (m)
(Thousands)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
8
10
12
(Thousands)
ACTUAL DISTANCE FROM HEAD (m)
Theor
L/Prep
16–25 Jan
7–17 Feb

FIGURE 6

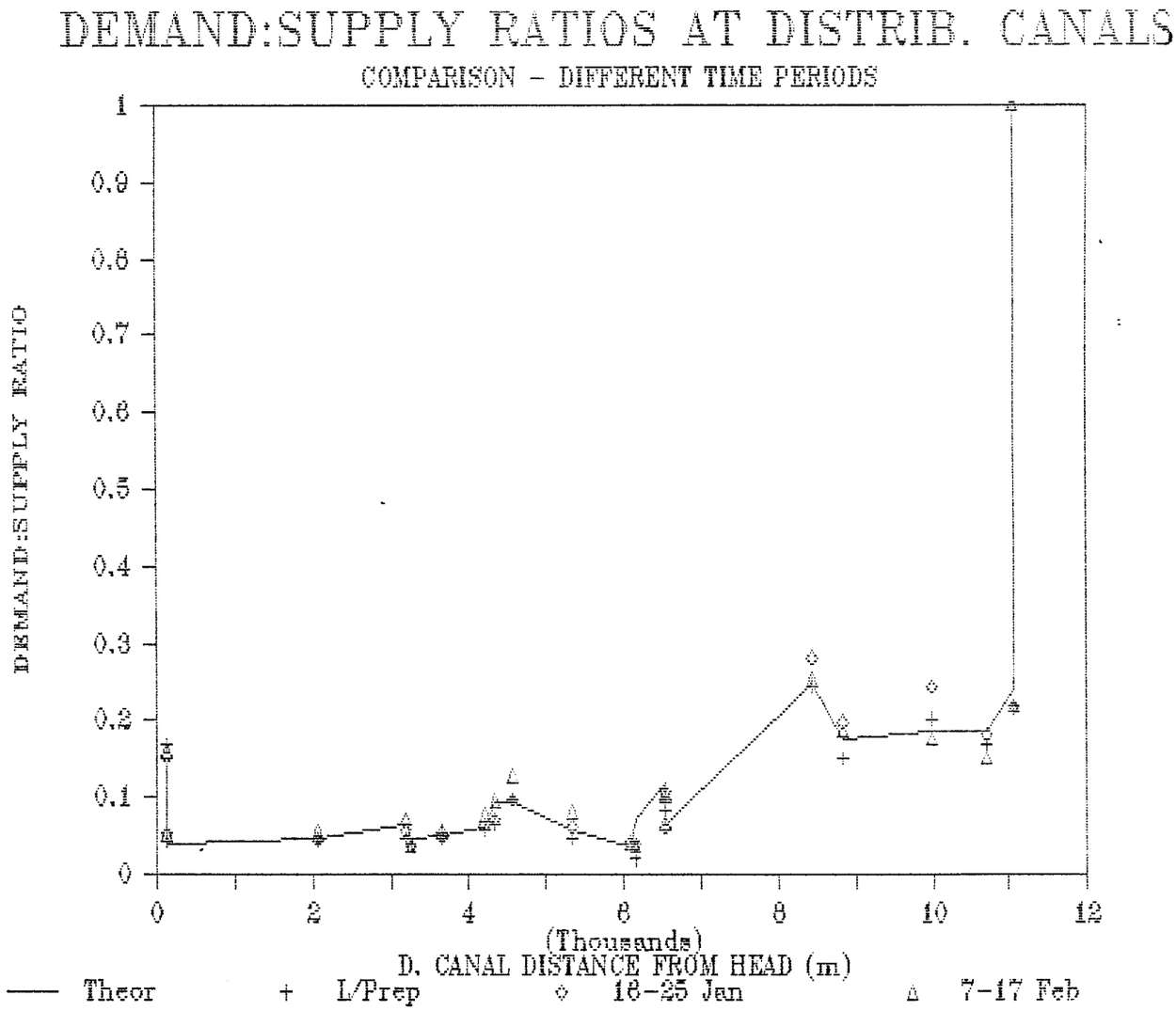

DEMAND:SUPPLY RATIOS AT DISTRIB. CANALS
COMPARISON - DIFFERENT TIME PERIODS
DEMAND:SUPPLY RATIO
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
8
10
12
(Thousands)
D. CANAL DISTANCE FROM HEAD (m)
Theor
L/Prep
18-25 Jan
7-17 Feb

FIGURE 7

Table 5

KALANKUTTIYA BRANCH CANAL - CALCULATION OF EQUIVALENT DISTANCES
USING ACTUALLY OBSERVED WATER FLOWS FOR THE ROTATIONAL PERIOD 7-17 FEB 1987
OF THE MAHA SEASON 1986/87

DISTRIBUTORY CANAL NO.	COMMAND AREA (ha)	LENGTH OF REACH (m)	CUMULATIVE DISTANCE FROM HEAD (m)	AVERAGE DELIVERY TO D. CANAL (m3/s)	AVERAGE DISCHARGE IN BRANCH CANAL (m3/s)	EQUIVALENT LENGTH OF REACH (m)	EQUIVALENT DISTANCE FROM HEAD (m)
FIRST PART OF ROTATION (7-12 Feb)							
305D1	295.5	122.0	122.0	0.000	1.727	0.0	0.0
308D1	71.9	0.3	122.3	0.000	1.727	0.0	0.0
305D2	76.9	1929.9	2052.1	0.000	1.727	0.0	0.0
305D3	106.3	1131.7	3183.8	0.000	1.727	0.0	0.0
308D2	69.8	63.4	3247.3	0.000	1.727	0.0	0.0
305D4	70.9	399.4	3646.6	0.000	1.727	0.0	0.0
306D1	85.0	551.8	4198.5	0.000	1.727	0.0	0.0
308D3	119.4	140.2	4338.7	0.000	1.727	0.0	0.0
306D2	109.1	230.2	4568.9	0.000	1.727	0.0	0.0
309D1	59.7	756.1	5325.0	0.142	1.727	62.0	62.0
306D3	35.4	759.1	6084.1	0.064	1.585	30.8	92.8
309D2	67.8	64.0	6148.2	0.054	1.521	2.3	95.1
309D3	104.3	379.0	6527.1	0.154	1.466	39.9	134.9
306D4	49.6	0.3	6527.4	0.088	1.312	.0	135.0
306D5	177.9	1893.9	8421.3	0.312	1.224	483.3	618.3
309D4	96.0	398.8	8820.1	0.171	0.911	74.8	693.1
309D5	84.0	1145.1	9965.2	0.131	0.740	202.8	895.9
307D1	67.6	718.9	10684.1	0.092	0.609	108.6	1004.4
307D2	70.9	361.9	11046.0	0.114	0.517	79.6	1084.1
307D3	221.7	0.3	11046.3	0.403	0.403	0.3	1084.4
SECOND PART OF ROTATION (13-17 Feb)							
305D1	295.5	122.0	122.0	0.606	2.033	36.4	36.4
308D1	71.9	0.3	122.3	0.166	1.427	.0	36.4
305D2	76.9	1929.9	2052.1	0.170	1.261	259.6	296.0
305D3	106.3	1131.7	3183.8	0.202	1.091	210.0	505.9
308D2	69.8	63.4	3247.3	0.101	0.889	7.2	513.1
305D4	70.9	399.4	3646.6	0.142	0.788	72.0	585.2
306D1	85.0	551.8	4198.5	0.183	0.646	156.0	741.2
308D3	119.4	140.2	4338.7	0.209	0.463	63.3	804.5
306D2	109.1	230.2	4568.9	0.254	0.254	230.2	1034.7
309D1	59.7	756.1	5325.0	0.000	0.000	0.0	1034.7
306D3	35.4	759.1	6084.1	0.000	0.000	0.0	1034.7
309D2	67.8	64.0	6148.2	0.000	0.000	0.0	1034.7
309D3	104.3	379.0	6527.1	0.000	0.000	0.0	1034.7
306D4	49.6	0.3	6527.4	0.000	0.000	0.0	1034.7
306D5	177.9	1893.9	8421.3	0.000	0.000	0.0	1034.7
309D4	96.0	398.8	8820.1	0.000	0.000	0.0	1034.7
309D5	84.0	1145.1	9965.2	0.000	0.000	0.0	1034.7
307D1	67.6	718.9	10684.1	0.000	0.000	0.0	1034.7
307D2	70.9	361.9	11046.0	0.000	0.000	0.0	1034.7
307D3	221.7	0.3	11046.3	0.000	0.000	0.0	1034.7

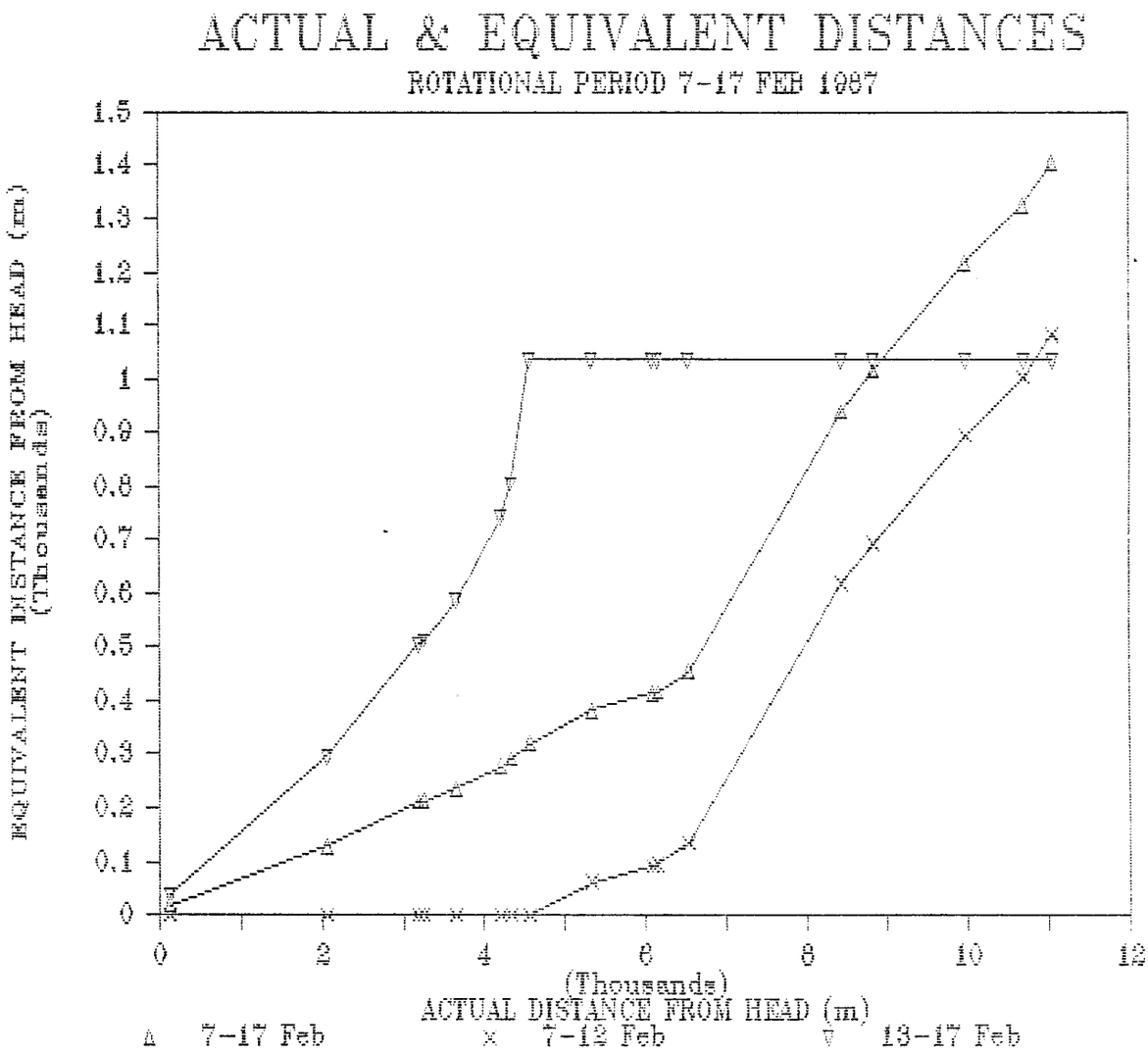

ACTUAL & EQUIVALENT DISTANCES
ROTATIONAL PERIOD 7-17 FEB 1987
EQUIVALENT DISTANCE FROM HEAD (m)
(Thousands)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
8
10
12
(Thousands)
ACTUAL DISTANCE FROM HEAD (m)
7-17 Feb
7-12 Feb
13-17 Feb

FIGURE 8

Table 6

KALANKUTTIYA BRANCH CANAL - CALCULATION OF THEORETICAL EQUIVALENT DISTANCES OF THE LOWER AND UPPER ROTATIONAL REACHES ASSUMING WATER REQUIREMENT OF 2L/S/HA FOR DISTRIBUTORY CANAL COMMAND AREAS AND 30% OVERALL CONVEYANCE LOSSES

DISTRIBUTORY CANAL NO.	COMMAND AREA (ha)	LENGTH OF REACH (m)	CUMULATIVE DISTANCE FROM HEAD (m)	THEORETICAL DEMAND OF D. CANAL (m3/s)	BRANCH CANAL DESIGN DISCHARGE (m3/s)	EQUIVALENT LENGTH OF REACH (m)	EQUIVALENT DISTANCE FROM HEAD (m)
UPPER ROTATIONAL REACH (305D1-306D2)							
305D1	295.5	122.0	122.0	0.844	2.871	35.9	35.9
308D1	71.9	0.3	122.3	0.205	2.027	.0	35.9
305D2	76.9	1929.9	2052.1	0.220	1.821	232.8	268.7
305D3	106.3	1131.7	3183.8	0.304	1.601	214.6	483.4
308D2	69.8	63.4	3247.3	0.199	1.298	9.7	493.1
305D4	70.9	399.4	3646.6	0.203	1.098	73.7	566.8
306D1	85.0	551.8	4198.5	0.243	0.896	149.6	716.4
308D3	119.4	140.2	4338.7	0.341	0.653	73.3	789.7
306D2	109.1	230.2	4568.9	0.312	0.312	230.2	1019.9
309D1	59.7	756.1	5325.0	0.000	0.000	0.0	1019.9
306D3	35.4	759.1	6084.1	0.000	0.000	0.0	1019.9
309D2	67.8	64.0	6148.2	0.000	0.000	0.0	1019.9
309D3	104.3	379.0	6527.1	0.000	0.000	0.0	1019.9
306D4	49.6	0.3	6527.4	0.000	0.000	0.0	1019.9
306D5	177.9	1893.9	8421.3	0.000	0.000	0.0	1019.9
309D4	96.0	398.8	8820.1	0.000	0.000	0.0	1019.9
309D5	84.0	1145.1	9965.2	0.000	0.000	0.0	1019.9
307D1	67.6	718.9	10684.1	0.000	0.000	0.0	1019.9
307D2	70.9	361.9	11046.0	0.000	0.000	0.0	1019.9
307D3	221.7	0.3	11046.3	0.000	0.000	0.0	1019.9
LOWER ROTATIONAL REACH (309D1-307D3)							
305D1	295.5	122.0	122.0	0.000	2.957	0.0	0.0
308D1	71.9	0.3	122.3	0.000	2.957	0.0	0.0
305D2	76.9	1929.9	2052.1	0.000	2.957	0.0	0.0
305D3	106.3	1131.7	3183.8	0.000	2.957	0.0	0.0
308D2	69.8	63.4	3247.3	0.000	2.957	0.0	0.0
305D4	70.9	399.4	3646.6	0.000	2.957	0.0	0.0
306D1	85.0	551.8	4198.5	0.000	2.957	0.0	0.0
308D3	119.4	140.2	4338.7	0.000	2.957	0.0	0.0
306D2	109.1	230.2	4568.9	0.000	2.957	0.0	0.0
309D1	59.7	756.1	5325.0	0.171	2.957	43.6	43.6
306D3	35.4	759.1	6084.1	0.101	2.786	27.6	71.2
309D2	67.8	64.0	6148.2	0.194	2.685	4.6	75.8
309D3	104.3	379.0	6527.1	0.298	2.491	45.3	121.1
306D4	49.6	0.3	6527.4	0.142	2.193	.0	121.1
306D5	177.9	1893.9	8421.3	0.508	2.052	469.2	590.3
309D4	96.0	398.8	8820.1	0.274	1.543	70.9	661.2
309D5	84.0	1145.1	9965.2	0.240	1.269	216.5	877.7
307D1	67.6	718.9	10684.1	0.193	1.029	134.9	1012.7
307D2	70.9	361.9	11046.0	0.203	0.836	87.7	1100.4
307D3	221.7	0.3	11046.3	0.633	0.633	0.3	1100.7

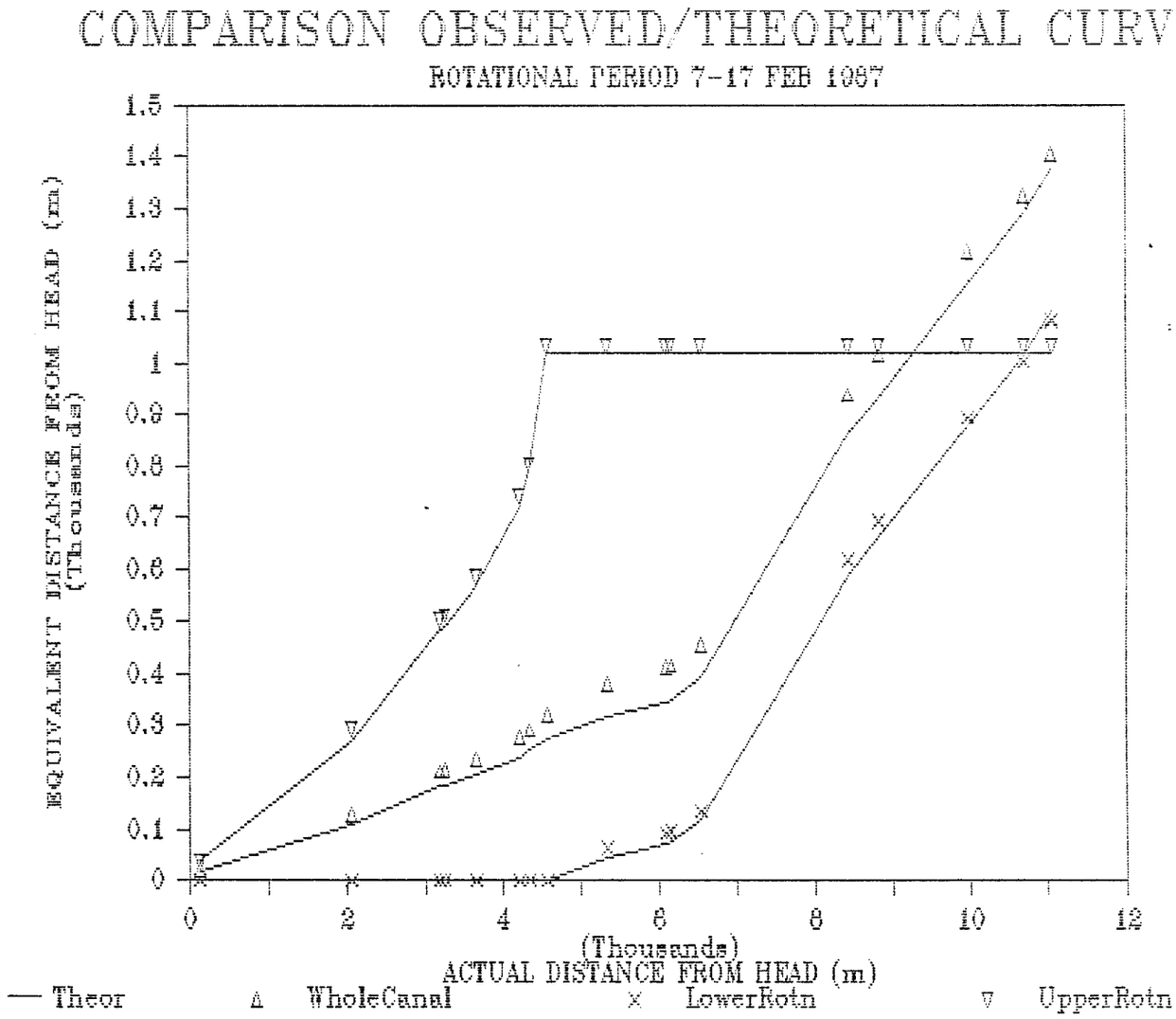

COMPARISON OBSERVED/THEORETICAL CURVES
ROTATIONAL PERIOD 7-17 FEB 1987
EQUIVALENT DISTANCE FROM HEAD (m)
(Thousands)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
8
10
12
(Thousands)
ACTUAL DISTANCE FROM HEAD (m)
Theor
WholeCanal
LowerRotn
UpperRotn

FIGURE 9

Table 7

KALANKUTTIYA BRANCH CANAL - CALCULATION OF AVERAGE WATER DELIVERIES
LAND PREPARATION, ROTN JAN 16-25, ROTN FEB 7-17
OF THE MAHA SEASON 1986/87

DISTRIBUTORY CANAL NO.	COMMAND AREA (ha)	LENGTH OF REACH (m)	CUMULATIVE DISTANCE FROM HEAD (m)	DELIVERY PER UNIT AREA LP (l/s/ha)	DELIVERY PER UNIT AREA R1 (l/s/ha)	DELIVERY PER UNIT AREA R2 (l/s/ha)
305D1	295.5	122.0	122.0	1.74	1.67	2.05
308D1	71.9	0.3	122.3	1.58	2.06	2.31
305D2	76.9	1929.9	2052.1	1.38	1.52	2.21
305D3	106.3	1131.7	3183.8	1.01	1.32	1.90
308D2	69.8	63.4	3247.3	1.25	1.21	1.44
305D4	70.9	399.4	3646.6	1.58	1.55	2.01
306D1	85.0	551.8	4198.5	1.42	1.63	2.15
308D3	119.4	140.2	4338.7	1.05	1.20	1.75
306D2	109.1	230.2	4568.9	1.59	1.64	2.33
309D1	59.7	756.1	5325.0	1.31	1.75	2.37
306D3	35.4	759.1	6084.1	1.74	1.89	1.82
309D2	67.8	64.0	6148.2	0.46	0.86	0.80
309D3	104.3	379.0	6527.1	1.27	1.46	1.48
306D4	49.6	0.3	6527.4	2.12	1.58	1.78
306D5	177.9	1893.9	8421.3	1.65	1.89	1.76
309D4	96.0	398.8	8820.1	1.41	1.78	1.78
309D5	84.0	1145.1	9965.2	1.88	2.01	1.56
307D1	67.6	718.9	10684.1	1.51	1.40	1.36
307D2	70.9	361.9	11046.0	1.55	1.32	1.61
307D3	221.7	0.3	11046.3	1.77	1.50	1.82

N.B. REACH ==> Distance between successive Distributory Canals


WATER DELIVERY TO DISTRIBUTORY CANALS
COMPARISON – DIFFERENT TIME PERIODS
WATER DELIVERY (l/s/ha)
2.4
2.3
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0
2
4
6
8
10
12
(Thousands)
ACTUAL DISTANCE FROM HEAD (m)
+ Land Prepn
◇ 16–25 Jan 87
△ 7–17 Feb 87

FIGURE 10

WATER DELIVERY TO DISTRIBUTORY CANALS

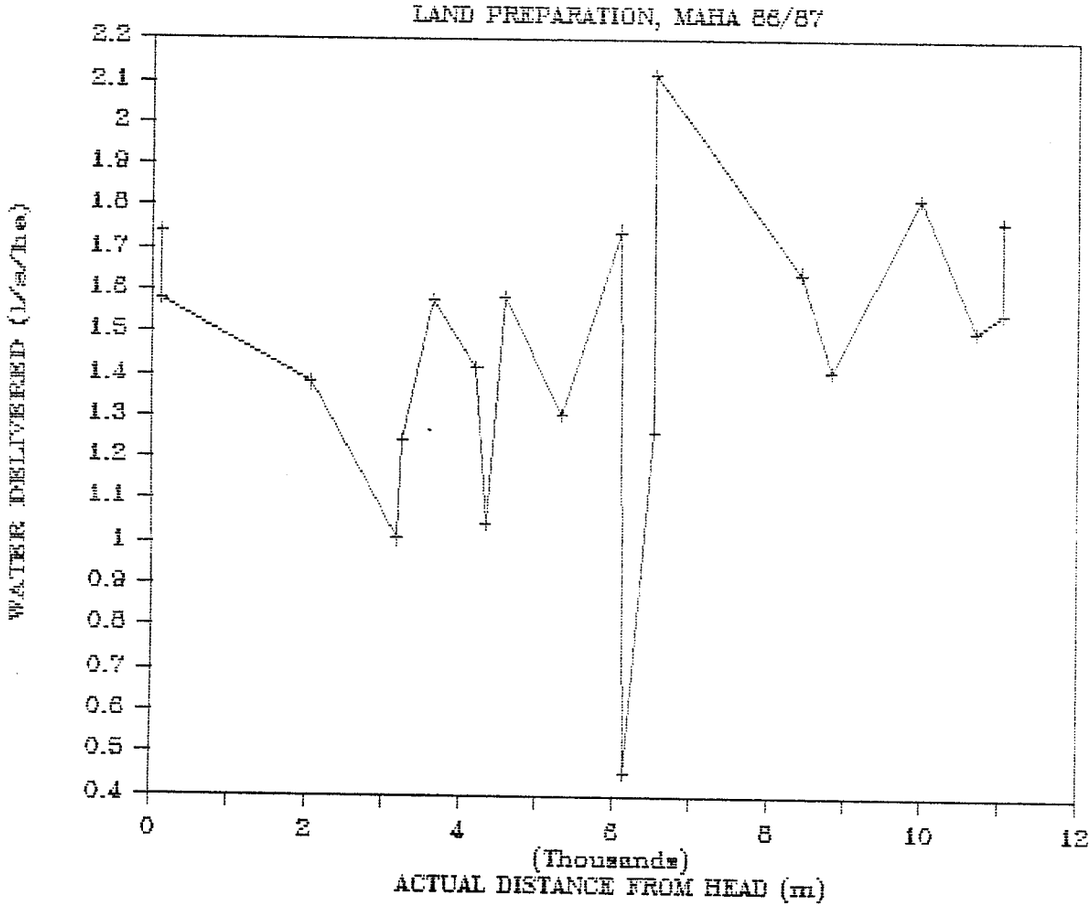


FIGURE 11

WATER DELIVERY TO DISTRIBUTORY CANALS

LAND PREPARATION, MAHA 86/87

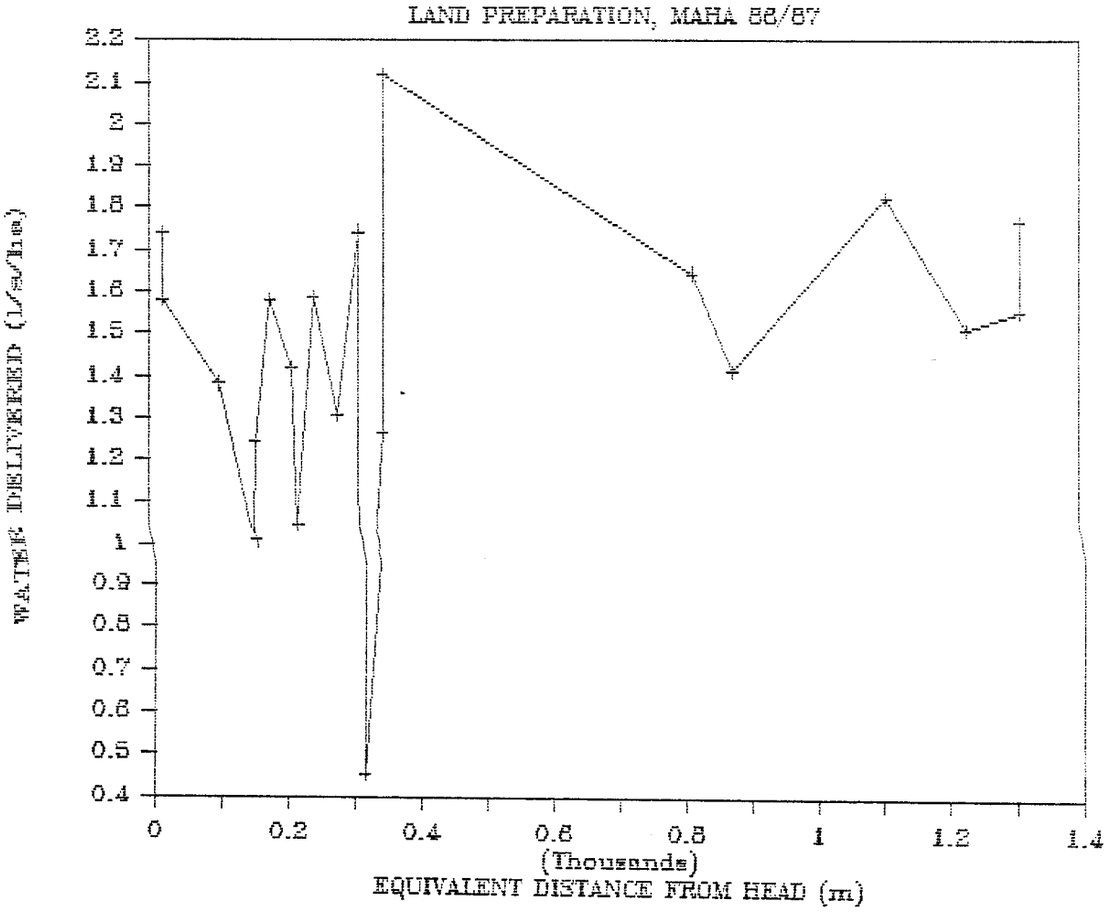


FIGURE 12